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A conference held in Washington, D.C. in May 1967, had as its objective the determination of recommendations for the establishment of an effective and efficient Automatic Data Processing (ADP) training program utilizing new instructional methodologies for computer systems analysts and managers in the federal government. The 45 participants, including subject matter specialists, resource specialists in programed instruction, educational technology manufacturers, ADP training consulting firms, industrial firms, and federal government officials concerned with the administration of ADP programs, attempted to determine behavioral objectives or training development goals and to list the subject matters which should be contained in the training programs. Recommendations of the conference were to develop through a pilot project (1) a methodology to determine who needs training in ADP, (2) a sequential and modular array of subject matter curriculum, and (3) a technique whereby the practitioner or student could diagnose his needs for training. Specific areas discussed include: (1) the environment and need for ADP training and development. , (2) ADP training in industry and in higher education, (3) development (2) ADP training in industry and in higher education, (3) educational media and ADP training. (MM)

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THE RELATIONSHIP OF ADP TRAINING CURRICULUM AND METHODOLOGY IN THE FEDERAL GOVERNMENT

AEDS NATIONAL CENTER FOR EDUCATIONAL DATA PROCESSING

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U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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THE RELATIONSHIP OF ADP TRAINING CURRICULUM AND METHODOLOGY IN FEDERAL GOVERNMENT.

FINAL REPORT.

Prepared by the

3 ASSOCIATION FOR EDUCATIONAL DATA SYSTEMS

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for the

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May, 1968

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I. INTRODUCTION

A. Objectives of the Conference

A conference entitled "The Relationship of Automatic Data Processing Training Curriculum and Methodology in the Federal Government" was conducted in Washington, D.C. during the period May 15-20, 1967 by the Association for Educational Data Systems and sponsored by the United States Office of Education. This conference had as its objective the determination of recommendations for the establishment of an effective and efficient Automatic Data Processing (ADP) training program utilizing new instructional methodologies. More broadly described, the purposes were: first, Federal Government agencies such as Office of Education, Civil Service Commission, National Bureau of Standards and the Bureau of the Budget have an immediate and pressing need to define those curriculums or bodies of subject matter knowledge required by two groups of federal employees: (a) the computer systems analysts and (b) the manager users. The participants at the conference attempted to determine the behavioral objectives or training/development goals for these two groups and to list in general terms the subject matters which should be contained in training programs for them. The second, and equally important purpose of the conference, was to determine to what extent educational multi-media courses could be utilized to efficiently produce effective training results in filling the enormous need for trained systems analysts and informed managers at all levels.

The major portion of this paper is directed to reporting the results of the conference in achieving the foregoing objectives. However, the major impact of the conference and this report is not contained herein but will come from the actions taken to implement the recommendations resulting from these meetings. The second stage of implementing ADP training with multi-media courses will come when, and if, a pilot project is established to implement the recommendations contained in this report. Moreover, it is hoped that it will be the intention of the Federal Government to achieve from the pilot project an operable prototype training program; rather than an experiment.

Finally, there was an expression of hope that the recommendations of the conference and the pilot project to follow would result in the achievement of these additional objectives:

1. Development of a methodology to determine who needs training in ADP
2. Development of a sequential and modular array of subject matter curriculum segments which would permit a training approach that exposes the student only to those modules which he requires. This would avoid the duplication and overlap so prevalent in existing programs
3. Development of a technique whereby the practitioner or student could diagnose his needs for training.

B. Events Leading to the Conference

In order to better understand the results and impact of the conference, it is helpful to briefly review the historical developments leading to its implementation and to this resulting report.

The need for new and innovative training programs has been under discussion for several years. Preliminary discussion began in 1964 when the United States Civil Service Commission released a report through the House Post Office and Civil Service Committee titled "A Study of the Impact of Automation on Federal Employees." Page 37 of the report (under Section V, Summary of Findings and Statements of approved actions) contains a reference to the establishment of a Joint Agency Commission.

> 3. Joint agency-Commission action is being taken to prepare for the future, in addition to improved forecasting of changes: The Civil Service Commission is establishing machinery for continuous discussion and action with the agencies in all personnel management program areas affected by automation. Cognizance will be maintained of developments in automation technology and applications. Future problems will be identified and action taken to mitigate their effects, as early and as rapidly as possible.

The implementation of this recommendation was fulfilled in a letter of October 29, 1964 from Mr. Irving Kator, Executive Vice Chairman of the United States Civil Service Commission. In this letter, reference was made to the establishment of an Interagency Advisory Group, Committee on Automation and Manpower (IAG-204). Mr. Hugh W. Scott, Personnel Management Specialist, Bureau of Programs and Standards was named Chairman of the Committee.

The first meeting of IAG-204 was on December 16, 1964. As stated in this meeting the purpose of this Committee was:

> "to provide a medium for executive branch collaboration on the personnel management and manpower aspects of automation in order to facilitate its utilization and to mitigate its adverse effects on personnel. ADP will be the primary concern of the committee, but the effects of other types of automation will also be of concern to it."

Five task forces of IAG-204 were then established in March of 1965. It was the defined responsibility of these task forces to examine their assigned subject area in depth and to make appropriate recommendations. These task forces were designated as follows:

Task Force I - The need for a special Civil Service examining program for computer specialists. (Mr. Sam McDonald - Census Bureau - Chairman)

Task Force II - Increased education of managers and key personnel in how the computer functions, its potential, and its shortcomings. (Mr. Fred Dyer - Department of the Navy - Chairman)

Task Force III - Improving placement programs for displaced workers. (Mr. Chet Evans - Department of the Treasury - Chairman)

Task Force IV - Establishment of Government-wide standards for projecting and reporting direct and indirect effects of automation on manpower requirements. (Mr. Leon Greenberg - Department of Labor - Chairman)

Task Force V - Keeping abreast of advances in automation technology and applications, and evaluating the extent and time of impact of the advances on personnel and manpower requirements. (Mr. Howard Gammon - National Bureau of Standards - Chairman)

At approximately the same period in time (March 1965), an extremely important and significant document was also released, making general reference to personnel training. This is commonly referred to as Senate Document 15, carrying the full and complete title of "Report to the President on the Management of Automatic Data Processing in the Federal Government." The report was prepared by the Bureau of the Budget and submitted through the Senate Committee on Government Operations. Page 3 of this report refers to the personnel problems facing the Federal Government and makes specific reference to the Civil Service Commission Study (already mentioned).

This report led to Circular No. A-71, from the Executive Office of the President, Bureau of the Budget and dated March 6, 1965. Circular A-71 defined the responsibilities for the administration and management of automatic data processing activities. Responsibilities for personnel training were assigned to the Civil Service Commission.

6. Responsibilities of the Civil Service Commission. -- The Civil Service Commission is responsible for providing executive branch-wide leadership and assistance in the personnel management and manpower aspects of automatic data processing. In this connection, the Commission will foster programs designed to --
   (a) Staff automatic data processing activities effectively by, among other things, (1) formulating position classification and qualification standards, (2) developing necessary special recruiting techniques, (3) devising improved testing and selection devices and (4) stimulating and coordinating necessary training.
   (b) Educate executives and other key personnel to achieve greater effectiveness in ADP management.
   (c) Anticipate and minimize, to the greatest practicable extent, any adverse effects of automatic data processing upon the people involved.
   (d) Provide a medium within the executive branch to focus and coordinate preparation for the future personnel management and manpower effects and requirements of automatic data processing.

These documents further indicated the importance of the work already begun by IAG-204, primarily through the previously mentioned task forces.

The organization of the task forces under IAG-204 called for Task Force V to establish sub-groups for more detailed examination of identified areas of automation advances. One of these sub-groups was the Subcommittee on Programmed Instruction, chaired by Dr. Chester L. Guthrie, National Archieves and Record Service. The purpose of the Subcommittee was to investigate the status of CAI (Computer Assisted Instruction) and its potential effects on the training of Federal personnel in ADP. After conversations with Mr. Francis Keppel, Dr. R. Louis Bright, Mr. David Bushnell, Colonel Gabriel O'Fiesh and others, the Subcommittee generally agreed that programmed instruction, in particular computer assisted instruction, held great promise as a possible means of solving certain personnel training problems in ADP, and should be explored in greater depth.

This agreement was transmitted in the form of a recommendation to the full Committee on Automation and Manpower. This recommendation was subsequently sent to the Civil Service Commission by Mr. Scott, Chairman of IAG-204. After several internal communications, the Civil Service Commissioners (Mr. John Macy, Chairman; Mr. L. J. Andolsek and Mr. Robert Hampton) authorized proceeding with the concept of CAI for ADP training and assigned CSC responsibility to the Office of Career Development.

Discussions for funding a program involving such training concepts were then directed to the United States Office of Education, where plans for a proposed working conference were discussed. It was determined that this could possibly result in an RFP for a CAI demonstration project for training Federal employees in ADP.

C. Participants

An outstanding group of conference participants representing experts in subjects related to the content of the conference were assembled. These included:

1. Fifteen topical specialists in subject matter, curriculum and education, and educational media technology.
2. Ten Federal Government officials concerned with the administration of ADP programs and associated training.
3. Two major resource specialists in the field of programmed instruction and CAI.
4. Eighteen additional resource specialists, including:
    a. Top Federal Government ADP Executives
    b. Educational Technology Manufacturers

c. ADP training consulting firms

d. ADP executives of industrial firms.

A list of participants is contained in Appendix II.

This report would not be complete without calling attention to those Federal Government officials whose efforts were particularly significant in the events leading up to the conference and in their leadership during its deliberations. These are:

Mr. Howard Gammon	National Bureau of Standards
Dr. Chester Guthrie	National Archives
Mr. Joseph Lowell	Civil Service Commission
Dr. Richard Otte	Office of Education
Mr. Hugh Scott	Civil Service Commission

D. Why ADP Training

Recent reports by the Civil Service Commission, including the Presidential Task Force on Career Advancement, estimate that two and one half million federal employees need some kind of training in either new skills or in updating the skill areas in which they now work. Why then, should computer training be chosen as the subject of this conference? The answer becomes rather clear; first, that ADP skills are among the most critical in both the government and private sectors. Since these skills are fundamentally the same in both sectors, training improvements developed by the Federal Government will have almost total transferability to industry. A second reason for choosing this area of ADP training and development is the conclusion that the innovative methodologies developed for this type training can be utilized across a wide range of other subject matter and skill areas. In summary, the results of this conference could stimulate thinking and action that might have a major impact on all types of training, not just in automatic data processing.

II. THE ENVIRONMENT AND NEED FOR ADP TRAINING AND DEVELOPMENT

A. Impact of the Computer

It is probably true that no event since the industrial revolution will have as profound an impact on technology as the computer. Indeed, as Mr. John Eberhart of the National Bureau of Standards expressed it, "We are in the process of passing from an Industrial to a Systems Revolution re: the impact of technology on society." The implications for Government and industry are essentially the same although the applications are somewhat different. Automation as found in industry for production planning, process control, and the like are applied in the Federal Government to large information processing and communications networks in which computers are an essential segment.

The impact of the computer in the Federal Government has been described:

> No single technological advance in recent years has contributed more to effectiveness and efficiency in Government operations than the development of electronic data processing equipment. Most of the important advances that have been made in such diverse fields as space exploration, research of all types, weather forecasting, and atomic energy would not have been possible without the computer. In the field of large-scale clerical operations such as insurance processing, checkwriting, and the tax system, the computer has materially assisted in producing major economies. Furthermore the computer is becoming increasingly useful to managers in solving complex problems involving interrelated types of information. The most notable of these have been in the military areas and in supply management. .....the impressive advantages to the Government already achieved through automatic data processing (ADP) are but steppingstones to the future.[1]

---

[1] U. S. Senate, Committee on Government Operations. The Management of Automatic Data Processing in the Federal Government. 89th Congress, 1st Session, March 4, 1965.

In industry, advances are equally spectacular. In the automobile industry for example, given the existing proliferation of products, it is estimated that it would take all existing employees to process the necessary paperwork under former manual systems methods.

The extent to which better applications and improvements can be made with computers appears to be limited only by the availability of trained people. This training problem and its implications have been highlighted by a Presidential Task Force on Career Advancement:

> Without question, the single most critical problem in ADP training is the need for understanding and support by top management
>
> and
>
> The second most important problem in ADP training is the acute shortage of ADP personnel.[2]

B. Growth of Computers and Computer Applications

It is difficult to trace historically or perdict the growth of computers because of rapidly changing technology. What is the yardstick of measurement? To say that installations have grown from 1,000 in 1955 to an estimated 50,000 in 1970 (AFIPS estimate)[3] is meaningless unless consideration is taken of some measure of the fantastic incrase in capacity (e.g., 1000 to 1 reduction in cost to perform calculation). However, by any measure the actual and predicted growth is phenomenal.

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[2] National Bureau of Standards, Training for Automation and Information Processing in the Federal Service. October, 1966.

[3] White House, President's Science Advisory Committee, Computers in Higher Education, The White House, February, 1967, p. 58.

According to the AFIPS study, the actual (1965) and estimated (1970) installations and the impact on manpower needs is summarized:

	1965	1970
Total Installations	30,000	50,000
Systems Analysts	60,000	200,000
Programmers	60,000	200,000-650,000
Operators	43,000	80,000

The impact of computers in the Federal Government is difficult to assess due to the large amount of effort utilized on government work (contractors, etc.) outside the government. Expenditures on hardware and software alone during the three most recent fiscal years averaged $840 million per year within the Federal Government. Personnel implications are clear when account is taken of the growing share of the expenditures devoted to software (42 percent in FY 1964 to 51 percent in FY 1966).

No precise measure of the impact of computers in industry is immediately available. However, it is expected that relative to government use, computer usage in industry will expand more rapidly because of the comparative few in that sector and the potential for additional applications.

In education, the President's Science Advisory Committee expressed the situation as follows: "After growing wildly for years, the field of computing now appears to be approaching its infancy." In 1965 the capital value of college and university computers was one twenty-sixth of the U.S. total and the cost of computers used in instruction, one-two hundred twentieth of this total. Annual expenditures by 1971-72 will amount to about $400 million if the recommended level of usage is attained.

The implications for training in all sectors is evident.

C. The Role of the Federal Government in ADP Training

Aside from the Federal Government's vast expenditures in education and its interest in training at all levels, comments of conference participants and other evidence point to additional reasons for a specific interest in ADP training. First is the tremendous need for trained personnel within government, present and future. This need will be outlined later in this report. Secondly, it is clear that government is in serious competition with industry and other users of computers for ADP personnel. Efforts directed to training the universe of ADP personnel will relieve the shortage and turnover in government. Finally, by developing improved methods and technology for ADP training, the government will have partially solved the problem of education and training in many other subject areas.

D. The Computer Systems Analyst (S/A) in the Federal Government

As background for placing ADP training in perspective, it was desirable at the conference to develop information concerning the tasks and skills of a Systems Analyst (S/A) and some definition of the need, the input sources, and a general measure of training needs. This background is reported here.

The Systems Analyst-Responsibilities and Duties

The Civil Service Commission has recently established a new position description for Computer Systems Analyst (GS9-12). This was taken as the starting point of the conference and is quoted here:

> "Computer Systems Analysts develop basic plans or "computer applications" by which subject-matter processes can be organized and accomplished by computer methods. They require a comprehensive understanding and analysis of subject-matter work

> processes, actions, criteria, as well as supporting controls, reports, documentation, etc., involved in the function to be automated. Also essential is the ability to devise procedures, to develop methods for generating and processing data, and to integrate these into data processing systems and plans. Typically, specific assignments may include: Feasibility or "profit-ability" studies; the development of detailed systems logic charts and diagrams; the development of data reduction and coding instructions, dictionaries, data banks, and the like. In addition, these positions require a substantial knowledge of computer capabilities and processes, and a basic understanding of programming principles and methods. They analyze and organize subject-matter work processes and functions so that they can be converted into workable computer programs and routines. Furthermore, systems analysts must be able to foresee some of the specific problems posed in the subsequent programming processes required, as well as some of the possible solutions to such problems."

This definition is in terms of output -- what is the end product -- a typical limitation of job description. The information needed to develop curricula is what the systems analyst puts into the system -- what he brings or should bring to the system.

There was general agreement amohg participants that this description fairly represented the job of a S/A. Some felt, however, that the depth of skills inferred by the position was greater than the supply of personnel which could be hired or retained at that grade level. Reflecting this feeling, one participant commented "this description is for a much heavier person...consequently, persons doing systems work are frequently occupying other positions and higher grades."

A slightly different view of the S/A was gained from top Federal ADP executives and consulting firms engaged in systems training. Their summary of the responsibilities leaned more to the "logical problem solver and designer" approach as expressed in these typical comments regarding what was expected of an analyst:

> "An understanding of the intellectual tools capable of being used to look at the relationships between complex activities."
>
> "Probe and evaluate objectives. Determine best methods for achievement. Design systems to accomplish and follow up to assure conformance."
>
> "Find the simplest ways of taking each objective in implementing a program and devising the methods and procedures that would attain the end result forecast."
>
> "Plan, factfind, analyze, determine findings, develop general systems design and documentation and oversee implementation."
>
> "Design of workable problem solutions for users."
>
> "Plan and design information systems in cooperation with various user groups in an organization. Deeply involved in implementation."
>
> "To take a logical approach to improvement of the system of the organization."

For purposes of ADP training, perhaps the most significant statement was the one developed at the end of the conference. This defined the objective of the training program as:

> "To provide those individuals who have adequate background in computer programming with the knowledge and skills necessary to contribute meaningfully to all basic phases of a systems project under competent technical supervision."

None of the foregoing views of the job or responsibilities of the systems analyst are in conflict. Indeed, all were taken into account in developing the curriculum of the training program.

The Need for Systems Analysts

The current and future shortage of systems analysts had previously been adequately documented and was reinforced at the conference. The 1966 Presidential Task Force on Career Advancement labeled the acute shortage of ADP personnel second in criticality only to the need for understanding and support by top management. This shortage was attributed to the increasing numbers of installations and applications as well as the recruiting and pay situation in industry as compared to government. Turnover was determined to be over 18%. This same report estimated the S/A shortage in the U.S. as 35,000 and the 1970 training needs as 130,000.

The on-board count of S/As in the Federal Government and the future need is difficult to determine due to the fact that: (a) S/A duties are being performed by other personnel, (b) discrepancies between military vs. civilian job descriptions, (c) the large numbers of S/As working for contractors not accounted for individually, and (d) the high number of S/As being shared by agencies of the government. There is unquestionably a serious shortage of S/As. One medium size agency stated that 45 vacancies for S/As now exist out of a total of 181 authorized positions.

Quantitative estimates of the need for S/A training in the future are difficult to determine accurately. However, a reasonably good estimate of the need did emerge from the conference.

E. Numbers of Systems Analysts Needing Training (est.)

1. Number in Government
    a. Direct, full involvement and needing full training

(1) Systems analysts and senior programmers performing System analysis activities as a part of their programming activities.	18,000
(2) Management analysts most of whom should be fully trained in system analysis procedures.	9,000
	27,000

b. Closely related and needing considerable training	
(1) Subject matter specialists oriented to, and participating in, systems analysis	30,000
(2) Administrative officials in responsible staff positions who require some knowledge of system analysis procedures	30,000
	60,000
2. Number in Industry	
a. Available systems analysts (1966)	60,000
b. Additional needs (1966)	35,000
	95,000
c. Other related occupations needing considerable training in system analysis (1966)	200,000
Total	295,000
d. Total needs for analysts by 1970	200,000
e. Total needs for other related occupations by 1970	300,000
Total both needs	500,000
3. Turnover in Government	
a. From one systems analyst job to another (change of agencies)	16%
b. Leaving Government	2.2%
c. Hires from outside Government	27%
4. New input to "profession"	
a. System analysts and senior programmers expected to do systems analysis	3,000 p.a.
(System analysts *per se* - 2,000 p.a.)	

5. Extent of need for updating
    a. All system analysts need at least 5 days of intensive updating a year.
    b. Existing system analysts needs (other than updating)
        (1) Programmer background only -
            6 weeks of general management principles and methods
        (2) General management analyst background only-
            4 weeks of basic mathematics
            4 weeks of "hands on" instruction in a basic programming convention

Sources of Input to Systems Analyst Manpower

It was important to establish the major sources of input to the supply of systems analysts in the Federal Government in order to subsequently determine in the conference a recommended subject matter training program for each major source of input. Although no quantitative measure of the size of each source could be determined at the conference, there was general consensus that the sources in order of quanitity of input were:

(1) Programmers
(b) College hires
(c) Related systems jobs
    Technicians and operators
    Methods analysts
(4) Subject matter personnel

F. The Manager in the Federal Government

The Presidential Task Force on Career Advancement adequately stated the need for managerial training at all levels:

> "Without question, the single most critical problem in ADP training is the need for understanding and support by top management....Although confirming data are not available to support the point, it is strongly believed that as many as 30 percent of upper level Federal Government managers and long service career employees do not understand, or even fear, the advent of ADP operations in their areas.
>
> Parallel to the need for top management understanding and support is familiarization training for middle management and staff personnel."

Participants at the conference were unanimous in the view that the majority of managers need familiarization with the computer and a remarkable degree of unanimity existed with regard to what and how he should learn it. This is not surprising in view of the existing and projected application of the computer into increasing phases of government operations. Closely associated with the need for the manager to know the computer as a user is the need for him to know it in order to close the "gap" between the ADP person and the manager, a gap that unquestionably is costly in terms of tiem, proficiency, and utilization of computer capability.

Although there was unanimous opinion among the participants that manager users contained a vital and large group of potential candidates for a training/familiarization program, it was difficult to estimate a precise number. This difficulty was due to three basic characteristics of the managerial and executive work forces:

(1) Impending retriement of a large percentage of Federal Government managers (One estimate was that 70% in the grades 11-16 would retire in two years). The question arises as to what extent, if any, these persons should be trained;

(2) The extent to which the chief executive of the agency understood, appreciated, and would permit or encourage agency employees to attend ADP familiarization or training programs;

(3) The extent to which ADP development programs should be directed to specific subject matter content or peculiar agency uses rather than a general overall familiarization program.

In spite of the difficulty of forecasting the need for managerial training and development, the conclusion clearly emerged from the conference that an enormous backlog did exist. An examination of the data below which was a consensus of the thinking of the conference experts will provide a measure of the need for managerial training.

G. Some Estimates on Number of Managers Needing ADP Training in Federal Government

1. Categories of Managers Needing ADP Training in Federal Government

Heads of Agencies	120
Top Staff in Agencies	1,200
Program Officers	4,000
Managers with Program Officers	20,000
Field equivalents (GS 14-18)	75,000
	100,320

Comment: The above figures equal 3.3% of the total Federal work force and apply to positions from the director of an agency down through lower middle management. The chart also includes military officer personnel in managerial positions. Training one-third of the above personnel is urgent, with the remainder very desirable.

H. Comparison of number of individuals

1. Federal employment GS 15 and above (and equivalent pay scales)	32,691
2. Field GS 14's having substantial responsibilities	25,000
3. Military performing executive duties	35,000
	92,691

Comment: A number of GS 14's in Washington probably also should receive managerial ADP training, because they are ready for promotion. Possibly 5,000-8,000 persons would be in this category.

I. Training Needs - Summary

From information obtained and discussions held at the conference the conclusion clearly emerges that a training/development gap of serious proportions exists in the Federal Government. Existing training organizations (i.e., CSC, DODCI, ADP Management Training Center, etc.) do an excellent job but at current training rates are not meeting attrition losses.[4]

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[4] Presidential Task Force on Career Advancement, Training for Automation and Information Processing in the Federal Service (Project E: Training for Specialization) National Bureau of Standards, October, 1966.

III. ADP TRAINING IN INDUSTRY AND IN HIGHER EDUCATION

A. Education in Industry

Industry, like government, is faced with the same general problems of training/development for the systems analyst and other ADP personnel as well as for the manager user. The problem in industry, however, is somewhat simpler due to three basic reasons:

1. Any particular or specific industry or company within an industry is vastly more specialized in its products or services and hence the design and other ADP problems to which training is directed can be more narrow in scope.
2. The specialization within companies, reflected in the financial considerations, permits a specialized approach to training and indoctrination. Moreover, this training lends itself more to the on-the-job variety.
3. The personnel entering the systems analyst field come generally better prepared because the two primary sources of input are experienced systems analysts and college graduates.

In spite of the less complex environment, industry in general and the computer industry in particular, is witnessing a new trend - the "education explosion." Symptoms of this trend are the 58 percent more "in-house" training programs in ADP between 1965-67.[1] Equally as significant is the vastly accelerating attention and participation by top management, including company presidents, in the increasing emphasis on training for ADP and other critical company needs.

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[1] Farr, Robert N., "EDP Education and the Objectives of Management", Systems, April, 1967, p. 13. An issue devoted to ADP training.

Because of the wide variations in the nature and needs of individual firms, no "average" or "typical" training program emerges for ADP personnel. This is true to a lesser extent for managerial personnel. The needs of this latter group are more clearly defined. Despite considerable variation in the source of managerial training (e.g., in-house, manufacturer, university, consultant) and the time devoted to it (typically 2-5 days), some common elements of subject matter generally emerge. Briefly, these might include:

Information Systems - concepts, components, functions, etc.
How a Computer Operates - operation of components, I/O devices
Programming and Software - including "hands on"
Planning - costs, feasibility studies, scheduling
Implementation - systems design, conversion, new applications
Personnel and Organization Impact
Role of Management - support of management, management uses.

Although no quantitative measures were available for comparison, the general impression received from the conference was that the depth and scope of training in industry (particularly at the managerial level) was somewhat less than in the Federal Government, although the growing amount of training that does exist in industry reaches more people in the organization.

B. Education in Colleges and Universities

Keeping pace with industry efforts is the university and college community. Undoubtedly broader in scope than either industry or government, this sector has rapidly accelerated into the fields of ADP, systems, computer sciences, management science, and related computer areas. In 1962 only four institutions offered degree courses in computer sciences; today one can earn degrees at over 200 institutions in the United States.[2] In the short space of two years (1962-64)[3] digital computers in use at colleges and universities rose from 397 to 1065. This, of course, is not to infer that these computers were being used for ADP training/education or for instructional purposes. However, the reader can predict for himself the enormous increase in computer education in the future if the recommendations of the President's Science Advisory Committee are even partially adopted.[4]

More pertinent to the purposes of this report is the extent to which a "systems" type courses are offered at colleges and universities. These have been rapidly growing in numbers. A 1966 study conducted by the Systems and Procedures Association[5] estimates that about 35% of the schools in the country will probably offer a degree in managmeent systems by 1971 and about 50% will offer a minor or major in this area. An indication of the growth is the fact that over 50% of systems courses being taught have only been offered within the past three years. The more than seventy courses being taught in 1966 were categorized by

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[2] Ibid. Of interest is the approach to systems education taken by the Carnegie Institute of Technology. As long ago as 1963 doctoral students were permitted to major in "systems" in five disciplines, all of which had "a common core devoted to techniques of analyzing and synthesizing complexity." Reported by Herbert Simon in Koontz, Harold, Toward A Unified Theory of Management. McGraw-Hill, 1964, p. 83.

[3] The latest date for which census data were available. Taken from Automated Education Handbook, Detroit: Automated Education Center, 1965, p. VII A 1.

[4] Computers in Higher Education, Report of the President's Science Advisory Committee. Washington, D. C.: The White House, February, 1967.

[5] Systems Education in the United States. Cleveland: Systems and Procedures Association, 1966.

Systems and Procedures Association into:

1. Introduction to Data Processing
2. Computer Programming
3. Management and General Business Systems
4. Mathematics and Engineering

The inference, indeed the conclusion, from the foregoing is that in spite of the growth rate of ADP and related education in colleges and universities, the number of those trained in these courses is accelerating at a rate substantially below the need for the computer industry, the Federal Government, and other users. For purposes of this report, one can point once again to the need for in-house education for federal employees, systems analysts and managers.

IV. TRAINING AND DEVELOPMENT OBJECTIVES

It is axiomatic among educators and people who design or administer training programs that the teaching process must be related to an objective; some predetermined body of knowledge which it is desired to transmit or a behavioral change on the part of the learner.[1] It is of little use to teach, for example, systems theory to an analyst unless it results in application or improvement of some sort. Similarly, "hands on" experience for the manager serves no purpose in an of itself unless better communications with ADP personnel, improved application in his own area, or other benefits accrue.

Pre-conference instructions and questionnaires asked participants to consider the matter of behavioral and other objectives of training/development programs. The matter of objectives and the expected end result of training were basic to all other discussions and were constantly reflected in questions such as these:

> "What do you look for in a systems analyst?"
> "What are the responsibilities of a systems analyst?"
> "How much does a manager need to know and why?"
> "Can you teach an analyst to sell?"
> "How do we close the manager-analyst gap?"

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[1] "The objective of training or education can be framed in terms of the problems to be solved." Quote from a conference paper delivered by Dr. Lawrence Stolurow of Harvard University on Computer Assisted Instruction. Similarly stated by Richard Shetler, President of General Learning Corporation, "The end process is learning, not teaching. I cannot emphasize this too strongly." See "Innovation in Education," Educational Technology, Washington, D.C.: The Aerospace Educational Foundation, Spring 1967, p. 9.

At that point in the conference where curricula were developed and reconsidered, the "image" of a systems analyst and the "educated manager" became clear and the objectives of training and development were established for purposes of defining subject matter content. These objectives are briefly described below.

A. Development Objective - The Manager

It is important to understand that when discussing the management "student," various complexities and some confusion arise due to many levels of managers, their needs for knowledge of automatic data processing, and the subject matter to which they might be exposed. Add to this the peculiar or specific nature of ADP applications according to their subject matter area or agency and the result is proliferation at best. This problem was resolved by: distinguishing two managerial groups, (a) top management, and (b) other managers. A basic curriculum which is common to both groups was then devised.

For top management, the consensus regarding objectives emerged as:

1. Orient and familiarize the manager to the end that his information processing system will be more productive by
    a. Establishing the role of ADP in the organization
    b. Providing tighter control over production of paperwork
    c. Getting the manager involved in problem solving (EDP doesn't solve problems; people do)
    d. Utilizing talents already in the organization
2. Closing the understanding and appreciation "gap" between management and ADP operations.[2]

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[2] "Almost no single action can be taken that would provide equal return in agency operations improvement, than for top officials to adopt a direct, favorable position toward ADP use and ADP training. Other ADP actions will be ineffective or even unsuccessful if such top management support is not forthcoming." Op.Cit., p.3, Presidential Task Force on Career Advancement.

3. Familiarizing the manager with the capability of the computer for improving management, effectiveness, and productivity through information.

Regarding lower levels of management the objective became more "practical". Whereas the top management objective was more directed to an appreciation and understanding of computer technology in relation to him and his organization, participants at the conference were of the opinion that the lower level manager needed this appreciation also but in additiion the training should be directed to how he could use computer technology in his operations. This was the essence of the recommendation although frequent expressions such as "enough training to understand the computer technician" or "so he can communicate with the analyst" were expressed.

Subsequently, during curriculum development and in establishing specifications for a pilot training project, the foregoing objectives were merged into one:

> To provide the manager with the knowledge and skills necessary to identify, understand and evaluate the potential and performance of the computer system in the accomplishment of his operations and mission objectives.

B. Training Objectives - The Systems Analyst

This report has already stated the CSC description of the duties of a systems analyst and pointed out (see page 11) that this was not always an adequate description. As stated by conference participants, this inadequacy usually related to his ability to think like a manager in designing systems and to his ability to communicate. Summarizing this view by top ADP executives and consultants were phrases such as:

"The Systems Analyst....

> should be trained to use ADP as a management tool."
> should bridge the gap between problem desk (input) and machine configuration (output)".
> must know how to solve problems on the computer."
> must know salesmanship and communication."
> must be a diplomat - know when not to use a computer."
> must understand input/output use of information - not throughout."

An analysis of the discussions and questionnaires from the conference, in which all in attendance participated, yielded additional information that produced an image or profile of the systems analyst. Based on this profile then, a training program for Systems Analysts should provide for:

1. The tools and techniques of systems analysis, design, and implementation (e.g., hardware, programming, documentation, scheduling, work processing, etc.).
2. Management principles. (Objectives, performance standards and the place of information in planning and controlling) Needed in order to design information systems for management use.
3. Logic and problem solving.
4. Systems theory and concepts (integrated systems, feedback principles, decision theory, application of management science to problem solving and design.
5. Communications - written and oral, including salesmanship.

V. CURRICULA RECOMMENDATIONS

A. Management Development Program

Participants and consultants were in basic agreement on the content and structure of a curricula for management development programs. This curricula with major topical and sub-topical subject matter headings is listed below.

COURSE FOR FEDERAL GOVERNMENT MANAGERS

I. HARDWARE AND HOW IT OPERATES

The workings of a computer

Capabilities, limitations, and potential

Input-Output devices

Software considerations

File organization and maintenance

Input-output documentation and display

New technology

Objective: To take the mystery out of computers and bring an understanding of how they operate and their capabilities and limitations.

II. "HANDS ON" EXPERIENCE

Programming one language
  Writing a program to solve one or more problems

Other language and sub-routine options

Objective: To bring an appreciation of how problems can be solved with a computer by getting the manager involved.

III. COMPUTER APPLICATIONS

Basic existing applications

Advanced applications

Future applications

Objective: To make the manager aware of potential applications in his job to the end that he can better utilize and participate in ADP applications.

IV. ADP IN THE FEDERAL GOVERNMENT

Information Economics - costs of ADP, cost-utility tradeoff, etc.

Planning for the System - costs, feasibility, maintenance, planning.

Environment of ADP in the Federal Government - legislation, regulations, etc.

Agency problems and plans

Objective: To place ADP operations in perspective with regard to specific constraints of the Federal Government and to describe cost, feasibility, and time considerations to the end that the manager will participate in and direct systems planning and utilization.

V. INFORMATION SYSTEMS THEORY

Management, information, and the computer

Information systems design

Analysis and basic design techniques

Objective: To familiarize the manager with essential nature of information and the basic principles and theory of analysis and design in order that his effectiveness will be improved by design participation.

VI. DATA PROCESSING AS AN AID TO DECISION MAKING

Logic, problem definition, and problem solving

Problem solving with the computer

Techniques of problem solving - linear programming, operations research, simulation, etc.

Examples and practice in problem solving - cases

Objective: To show the manager that people, not computers, Solve problems. To improve his decision making and problem solving ability so that he may become more effective with the computer.

VII. ORGANIZATIONAL IMPLICATIONS OF THE COMPUTER

Impact on personnel and staff

Organizational changes and manpower consequences

Role of ADP personnel

ADP training

Objective: To get the manager to adopt a favorable position toward ADP, ADP training, and to provide an environment in which the effectiveness of ADP is optimized.

B. Systems Analyst Training Program

During the initial efforts to develop a curriculum for Systems Analysts, attempts were made to establish separate curricula for each source of input to the program (programmer, operator, methods analyst, college hire, etc.). This approach was found to be not only somewhat impractical but on the whole undesirable. A more practical and desirable approach was determined to be one in which an ideal or "total" body of knowledge required by an analyst could be defined, and that the prospective trainee, no matter what the source of input, could select, by means of a diagnostic process, those modules or elements of the "total" curriculum which he required. This, of course, would apply as well to the existing analyst who required updating.

As in the case of the curriculum for management development, a remarkable degree of agreement existed among participants and consultants regarding the structure and content of the total training program curriculum for the systems analyst. This program is listed below.

CURRICULUM FOR SYSTEMS ANALYSTS

I. ANALYSIS AND DESIGN CONCEPTS

A. PROBLEM SOLVING

The theory and practice of logic, decision making, and creative thinking. The use of these and other problem solving principles in the analysis and design of systems.

B. ORGANIZATION PRINCIPLES

Classical and contemporary principles of organization design and analysis. An understanding of the structure, decision centers, information flow, and other organizational considerations in systems design.

C. MANAGEMENT

The basic functions of management with special emphasis on planning and controlling through information systems. Consideration and understanding of facilitating the management process with systems.

D. SYSTEMS PLANNING

Determining systems objectives and planning time, cost, and resource allocations. Design proposals. PERT/CPM Input/output considerations.

E. SYSTEMS THEORY

Theory of information systems operation and design. Control theory. Integrated and total systems concepts. Planning and control through information feedback systems.

F. SYSTEMS EVALUATION

Measuring efficiency against goals. Input-output review and review of objectives.

G. HUMAN INTERACTION IN SYSTEMS

Gaining acceptance and "selling" ADP. The impact of automation on personnel. Getting cooperation. Interpersonal relationships. Applied psychology.

H. QUANTITATIVE TECHNIQUES IN SYSTEMS DESIGN

Application of operations reserach and other management science techniques. Formulation of decision rules. Simulation and modeling.

II. ANALYSIS AND DESIGN TECHNIQUES

A. SYSTEMS PLANNING

Network analysis technique for logical structuring of planning. Preliminary systems survey. The feasibility study. Cost evaluation and analysis. Analysis of time requirements. Planning quality elements of the system.

B. SYSTEMS ANALYSIS AND DESIGN

Analytical techniques and documentation (work measurement, flow charting, forms design, source data automation, etc.) Input/output alternatives. Communications, interviewing, and selling. Principles of systems design.[1]

C. IMPLEMENTATION AND FOLLOW UP

Planning, site preparation, personnel, organization, other considerations. Training the user. Evaluation and audit.

III. COMPUTER CONCEPTS AND CAPABILITIES

A. HARDWARE CHARACTERISTICS

Mainframe capability, peripheral equipment remotes and linkage, input-output devices, time sharing, on line sytems, etc.

B. SOFTWARE

Language options (COBOL, ALGOL, FORTRAN, etc.). Other software options (compilers, subroutines, etc.)

IV. ADDITIONAL SKILL REQUIREMENTS

A. PROGRAMMING

Ability to program in one language

B. QUANTITATIVE TECHNIQUES

Management science techniques in systems design

C. COMMUNICATIONS

Graphics and visual presentations. The oral and written staff report.

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[1] A new body of systems principles analagous to principles of management. See Ross, Joel E. and Sullivan, J.W., Development of Systems Theory, Colorado Springs: Foundation for Administrative Research, 1967.

C. Additional Considerations - Structure and Time

Federal Government officials involved in ADP training made it quite clear from the beginning of the conference that the subject matter of the programs should be designed in modules; standard units of subject matter content, clearly defined and distinguishable so that the trainee (manager or analyst) would only be required to be instructed in those modules which were unfamiliar to him. This approach was variously described as a "menu" or "shopping list" from which the student could select those areas in which he required updating or initial exposure.

The desire to structure the program in this fashion is understandable in view of existing ADP training programs. Almost invariably, in the conventional seminar or training program, the audience already has varying degrees of familiarity with the subject matter. The result is lost time, duplication, boredom, and other unfavorable results. It becomes rather clear that the modular approach, particularly if individualized, is more efficient, involves less time, and results in better quality instruction.

Some interest and desire was also expressed in a sequential or "building block" concept of instruction. This approach is illustrated by the usual method of instruction in mathematics; arithmetic-algebra-calculus-differential equations, etc. This is also the general approach to programmed instruction; moving from the simple to the complex.

The question whether the recommended ADP programs should be approached in this fashion is a complex one and was largely unresolved at the conference. Given the complex environment of the Federal Government (many inputs, various levels of knowledge), it would be difficult at best to design the training program in this manner.

The trainee's time that should - or could - be devoted to the program was also discussed at length. This amount of time is a function of several unknowns such as manager's time, level of knowledge brought to the course, and the desire of the agency head. To the extent possible, these unknowns were estimated and the level of full time (classroom equivalent) effort required by the student to complete the curricula of instruction developed was determined to be:

1. For the manager - between 40 and 80 hours
2. For the systems analyst - between 120 and 180 hours.

VI. EDUCATIONAL MEDIA AND ADP TRAINING

A. Automation and Technology in Education[1]

There can be little doubt that educational technology in the United States stands on the threshold of becoming a major industry.[2] Properly applied, it holds great promise for upgrading and increasing the productivity of our educational effort in all areas. Some of the promises, problems, and cautions surrounding the application of educational technology were expressed at a recent seminar held by the Aerospace Education Foundation:[3]

Dr. R. Louis Bright Associate Commissioner U. S. Office of Education	The education market ranks second to defense. The problem of education and use of technology requires a systems approach between educators and industry.
Dr. Richard Bolt Chairman, Bolt, Beranek, and Newman	Technological transformation of the classroom is inevitable in the face of the population explosion and the increasing demand for education.

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[1] Author's note. It has not been the purpose of the conference or of this report to undertake a review of the state of the art in educational technology. For those readers who wish to do this, several bibliographic and other sources are available. For example, see the annotated bibliography (Appendix E)of this report. Also, Hickey, Albert E., Computer-Assisted Instruction, A Survey of the Literature. Newburyport: ENTELEK, Inc., 1967 (ONR Contr. 4757(00). Also, Automated Education Handbook, Detroit: Automated Education Center, 1965. Also, "Innovation in Education," Educational Technology, Spring 1967. Annotated references to particular subjects may also be obtained by the Defense Documentation Center.

[2] "The American economy was built around the railroads in the last half of the 19th century, around the automobile in the first two-thirds of this century, and it will be built around education in the balance of this century." Witness before hearings of Subcommittee on Economic Progress of the Joint Economic Committee. U.S. Cong., Automation and Technology in Education, 89th Congress, 2nd Session, August, 1966.

[3] Educational Technology, Op. Cit.

Dr. Calvin Gross Dean, School of Education University of Missouri	Urged acceptance of the cost/effectiveness concept in education and how increased capital investment in technology can achieve greater productivity and effectiveness.
Richard Shetler President, General Learning Corporation	We should be seeking "validated learning systems" achieved through a system including equipment, procedures, materials and personnel.

In spite of its great promises and prospects, educational technology has had something less than widespread adoption in the educational environment. Computer assisted instruction, in particular, has been confined largely to the laboratory or experimental situation. Educational "software" is generally not available and much equipment is highly developmental and experimental. The Subcommittee on Economic Progress of the Joint Economic Committee has outlined the generally accepted factors which will govern the potential contribution of educational technology in the future:

1. Effectiveness of research in learning theory and its application to the development of education;
2. Improvement of curriculum programming, particularly in respect to defining and meeting educational objectives;
3. Organization of our school systems and intelligent planning of curriculum;
4. More effective use of teachers; and
5. Recognition on the part of teachers and educators of the great potential in the new educational technology.[4]

It appears that any "across the board" adoption and use of educational technology does, indeed, face many problems. However, with regard to the objectives of the conference on which this paper reports, the conclusion emerges that most of the prerequisities to application of technology for ADP training are solved and present. Given the objectives, environment, curriculum, and other prerequisites to ADP training in the Federal Government, there was no expression of substantial reason why such training should not proceed.

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[4] U. S. Congress, Automation and Technology in Education, Op. Cit., p. 8

B. Present and Future Use of Media in ADP Training -Conferees

In this section of the report the reactions and plans of conferees regarding use of educational technology will be reported. Because of the different approaches and interests in the problem, conferees will be reported in three groups; (1) equipment manufacturers, (2) ADP executives and consultants, and (3) other conferees.

Representatives from educational equipment manufacturers (Appendix II) were unanimous in their expectations and in their praise of multi-media and educational technology applications in the near and longer term. Each company planned for extensive marketing efforts and the forecast of sales and profits were substantial. As a result of these plans and forecasts each company had undertaken reorganization and other efforts to insure that top level corporate attention was given to this growing market.

Each agreed that the industry and its applications were complex. The answer lies not in the development and marketing of specific items of hardware but in the systems approach; the "orchestration" of media, software, and educator's use and acceptance. A variety of talents and resources are necessary in the systems approach to insure the coordination and utilization of an educational "package' instead of the piecemeal approach taken to date. And yet, events are moving so rapidly that the user cannot wait for standardization and proven validity in either hardware or software. Indeed, to wait for or enforce standardization and maturity in development would mean stifling creativity and experimentation; elements that are so badly needed in the current state of development.

Each agreed that computer assisted instruction (CAI) was much broader in its application than the simple tutorial dialogue envisaged by the general public and most educators. CAI includes simulation, problem solving, and the automated use of all forms of media.

In many respects, CAI is a broader and more sophisticated application of programmed instruction (PI) and each participant was lavish in his praise for PI. Each has extensively utilized PI or PI with other forms of visual media for inter-company training, both in ADP and in other subject matter areas. It was agreed that experience in PI (written) provides the experience and head start necessary to move into CAI. Only one manufacturer (IBM) had made significant use of CAI for ADP training. Results had not been sufficiently validated for release to the general public although one participant, Dr. Sylvia Charp of the Philadelphia School System, reported very enthusiastic response from the use of the program on an experimental basis in Philadelphia.

Without exception, representatives of equipment manufacturers reported the number one problem as software; not machine languages but the shortage of subject matter specialists who could define educational objectives, arrange instructional material in programmed format, or otherwise program curriculum material for application and use on technological hardware - whether CAI or otherwise.

Without exception, manufacturer's representatives were enthusiastic about the use of multi-media technology to ADP training over the near and longer term. Most predicted that software costs, both in time and effort, could and would be reduced with new knowledge and technology. In general, the opinions were that CAI in its broadest sense and in its several modes contained the answer to individualized, effective ADP training.

C. ADP Executives and Consultants

With two or three exceptions, ADP executives and consultants (See Appendix II) reported that their ADP training techniques were conventional (sometimes described as primitive) and that media consisted largely of chalk and blackboard. All agreed that something must be done to fill the training gap but individual companies had done little, due to the non-availability of curriculum material programmed for media and the expense of developing it on an individual basis.

Most of the participants reported that written PI had been used and uniformly good results had been obtained when properly supervised. Some had utilized TV tapes or motion pictures where these have been available.

Each member of this group singled out managerial training as a special case. Becuase of the scarcity of time available to managers and their reluctance to undergo classroom or formalized instruction, some type of media approach is devised to get and hold their attention. This approach was variously described as "schmaltz" or "show businss" in order to get the manager involved. Slides, movies, television, modeling, graphics and other tools were described as in use and one executive reported that the well designed program using these media can cut the time required down by a factor of ten to one. There is, of course, no reason why this approach would not work for other groups (i.e., systems analysts) as well.

An outstanding exception to the mediocrity of structured in-house company training is the case of the American Telephone and Telegraph Company in New York City. Terminal use for enterprise modeling, simulation, programming and other subject matter areas is utilized in this company as part of a formalized program utilizing the latest in educational media.

D. Other Conference Participants

Workshop participants represented a wide range and variety of subject matter specialists, curriculum and education specialists, PI and CAI technical specialists, and Federal agency officials concerned with ADP training. (See Appendix II). It was not surprising to find an equally wide range of experiences with various educational media. About half of the participants (many from Federal Government) stated that ADP training in their organization consisted largely of conventional lectures and discussions sometimes accompanied by slides or other visual aids. Other incidents of media described as successful were written PI, programmed films, television, and simulation. Except for Federal Government participants, virtually all the remainder had plans for increased use of media in the future. Many were planning for increased utilization of PI and CAI.

No consensus developed among participants regarding the use of educational technology for ADP training in the future. This is to be expected in view of the complexity of the environment in which ADP training takes place in the Federal Government. As one participant stated, "You can't determine reliability and validity of specific media for particular purposes until objectives of the program are clearly identified. Time, money, and place constraints, as well as variability of individuals entering the program are all more significant than the media to be utilized."

Almost all participants felt that the use of media (film, film strip, slides, audio tapes, television, simulation, computers, PI, CAI, etc.) improved instruction. The majority felt that CAI in its broadest sense held great promise for ADP training, provided adequate software became available. There was general agreement that if one could ignore cost considerations (one not adequately discussed at the conference), some form of CAI utilizing multi-media was probably the best approach to ADP training in the Federal Government if the objectives of indvidualized mass instruction with modular design of subject matter were to be achieved. The general acceptability of multi-media and CAI for ADP training is reflected in the recommended specificiations for a pilot project contained in Appendix I.

E. The Problem of "Brainware"

No other single item of discussion surrounding educational technology was more prevalent than the problem of "software" - that effort required to convert subject matter to a form which can be retrieved by the learner in a manner that will achieve the educational objective. This problem remained central to all considerations of utilizing CAI and other media. Many felt that the term "software", having the connotation of programming the hardware, did not adequately express the task or resource required for programming the course content. The term "courseware" or "brainware" therefore is more appropriate for this difficult task which so often is the bottleneck in adequate utilization of educational hardware.

There is little question that the foregoing problem is central to any consideration surrounding the development of an ADP training program in the Federal Government. It was well expressed by the representatives of one of the nation's largest companies involved in educational technology, "The preparation of curriculum or instructional programs is a long process requiring careful professional effort. It can only be handled by a group of professionals including teachers, media specialists, technologists, etc., operating in a carefully planned and scheduled de-developed program. 'Hardware' is basically not a problem, but 'software' is the intelligence of the system and therefore the critical item. One should be particularly wary of 'GIGO' in instructional systems."

APPENDIX I.

SPECIFICATIONS FOR REQUESTS FOR PROPOSALS (RFP)

A. Specification for Requests for Proposal (RFP)

Reported herein is the consensus of expert opinion regarding the general description of and specifications to be included in an RFP for a pilot project to conduct ADP training in the Federal Government.

B. General Nature of the Project

Establish a training facility in the Washington, D.C. area designed to serve as a pilot effort in the use of individualized instructional media and hardware. This facility will serve as a prototype of similar facilities to be located in other key cities in the United States and in other Washington locations.

The project involves the development of two training packages, utilizing the curriculums listed in the main body of this report. The two groups of participants of 25-150 each are (a) Federal Government managers and (b) systems analysts. The specific objectives of the training are:

Management Course	Systems Analyst Course
To provide the manager with the knowledge and skills necessary to identify, understand and evaluate the potential and performance of the computer in the accomplishment of his operations and organizational mission objectives.	To provide those individuals who have adequate background in computer programming with the knowledge and skills necessary to contribute meaningfully to all basic phases of a systems project under competent technical supervision.

The courses should be aimed, as a general policy, towards individualized instruction utilizing the most advanced but feasible and valid instructional media, including computer assisted instruction. To this end the contractor shall explore and report on all media of instruction and identify, specify, and locate the equipment necessary to conduct two pilot demonstration projects.

Participants in the pilot courses will be selected from a variety of agencies and activities by the designated agency. Selection of participants will be made according to the following criteria:

Management Course

1) GS-14 or above, or equivalent
2) Persons who are not now and have not been "computer professionals"
3) No prior computer knowledge is assumed.
4) Participants will be mature individuals; however, no formal educational background beyond high school will be required.

Systems Analysis Course

1) Experience or hands-on training in computer programming
2) Passing of a mathematical aptitude test equivalent to first year college algebra
3) No single pattern of Federal experience will be assumed; younger students will tend to have recent academic backgrounds - however, students will be selected on the basis of general experience.

Participants will have varying degrees of education, experience, and academic background. Participants in the systems analyst course will be from a variety of input sources, including programmers, methods analysts, systems analysts requiring update, and new college hires.

It can be assumed that the level of full time (classroom equivalent) effort required by the student to complete these courses should be:

a) Managers course - between 40 and 80 hours

b) Systems analyst course - between 120-180 hours. (Students in this course can be required to perform additional homework assignments)

C. Specifications for Instructional Program

1. Instructional programs will be prepared to facilitate the curriculums outlined in the main body of this report (pp. 28-33)

2. Instructional programs will be organized into modular units to permit independent selection of only those units in which the student is not proficient by reason of education or training.

3. To implement the instructional program and the concept of individualization a system will be devised which will indicate the choice and sequence of modules appropriate for students with various levels of knowledge at entry and various performance requirements of the student. This sytem may include a tabular description or matrix of selection criteria (e.g., IQ, mathematical aptitude, education, experience, etc.) for each module and a procedure to test criteria. The system is diagnostic in the sense that the program director can determine the participant's entry level in the modular program.

4. Instructional program development will include recommendations of methodology for each module, including media alternatives (PI, texts, film, CAI, etc.) and pedagogical techniques (case history, simulation, etc.).

5. Where the contractor bids on instructional programs only, such bids shall include the actual instructional materials ready to be written in problem-oriented language for machine processing (in the case of CAI) or prepared on other similar appropriate media.

D. Specifications for Media/Hardware

1. All hardware should be adaptable to both central and remote utilization and capable of being expanded in the number of students that can be accommodated.

2. To the extent that new equipment is developed for the pilot project, it should be approved before utilization in such areas as human engineering for utilization to promote a good learning environment.

3. Primary consideration shall be given to equipment presently available within the Federal Government.

4. Contractors proposals will recommend specific media or combinations thereof for instructional module. One or more areas should be devoted to individualized CAI.

5. Classroom instruction with remote units in order to provide for individual consoles in group instruction sessions should be developed in one or more areas. For example, a lecture in simulation could be supplemented with individual student exploration of the effects of various inputs to a model.

6. Provision must be made for the capability to employ conventional training aids such as chalkboard, screens, closed circuit TV.

7. The following general characterisitcs are considered desirable in the instructional system. However, cost-effectiveness tradeoffs should be examined and reported.

   a. Multi-media presentations

   b. Computer controlled

   c. Human engineering, design criteria

   d. Mechanical equipment "sign on" and student identification (key for machine and identification badge for student)

   e. Modular design. Major components should be sufficiently independent to facilitate replacement upon failure to minimize 'down time'.

   f. Self checking. Equipment design to provide sensing devices to detect component failure and such information to be relayed to a central source for monitoring equipment performance. This design to be augmented by a student trouble indicator to serve the same purpose.

g. Individual media requirements

Manual
Full typewriter keyboard
Light pen (or provision for acting upon student touching of screen)
5 to 10-key response keyboard

Audio
Speaker and head set with stereo capability
Audio level under program and manual student control
Norm/compressed speech mode switch
Speech compression level under program and student manual control

Voice
Provision for voice response input for program control
Voice recording and playback under program control

Visual
CRT - provision for rear projection of film media on to face of CRT. Brightness under program and student manual control. Closed circuit TV coupling, random access video tape image selection

Rear Projection Screen
Projection device to be cartridge loaded by student (film or slide) with capability of randomly projecting individual frames, switching picture to either screen or through CRT to the tube face. Projection speed to be under program control.

"Fixed" Instruction Panel
Capable of displaying minimum of ten lines of 25 characters each. Illumination of appropriate line under program control and lines so constructed that they may be modified in content to fit authors' requirements.

h. Acceptance and selection criteria

Contractor should be able to demonstrate the reliable functioning of all system components under conditions of simulated usage. Testing should be for a period of no less than 100 hours, the last 40 hours of which must have at least 95% up-time with no more than 10 failures overall and of these 6 must be for periods of less than 5 minutes.

Qualitative factors to be considered in the evaluation of equipment performance. Given similar equipment design and functioning, preference in selection will favor those contractors whose equipment demonstrates superior quality in

h. (continued)
the following areas of human engineering (to include esthetics)
Low noise levels
Sharpness/resolution of image projection
Audio outputs
Function layout of display elements and controls
Rapidity of component response
System restart in the advent of computer and/or power failure

E. Contractor Criteria

1. Contractor shall have demonstrated competence in curriculum development, educational media, computer equipment, software development.

2. List complete qualification data of employees, both administrative and professional and technical on the project.

3. Any substitution of personnel in Item 2 (above) will be with prior approval of the contracting officer.

F. Time Schedule

The time schedule for design and implementation of the pilot project is shown below.

Event	Cumulative calendar days from Request for Proposal
RFP	0
Expression of bidder interest	30
Receipt of proposals	104
Selection of contractor	194
Award signed contract	224
Preliminary report of contractor	254
Pilot installation availability (including declaration by contractor of readiness to accept student groups)	700
Commence pilot courses	790
Contractor's final report will be due within 60 days of completion of pilot course	

Proposals will include milestone reports covering minimally:

1. detailed outline of curriculum
2. media
3. software

In addition, monthly project reports will be required of the contractor. One or two expert consultants should be engaged to assist the contracting officer in the supervision of the contract.

APPENDIX II

Conference Participants

PANEL A

Panel of Top Government ADP Executives

Miss Ann Lamb
Bureau of the Budget
Washington, D.C.

Mr. Edward Dwyer
Assistant Commissioner, ADP Management Services
General Services Administration
Washington, D.C.

Mr. John P. Eberhart
Director, Institute for Applied Technology
National Bureau of Standards
Washington, D.C.

Mr. Carl Clewlow
Deputy Under Secretary of Defense
Department of Defense
Washington, D.C.

Mr. Charles Sparks
Deputy Director
Bureau of Management Services
Civil Service Commission
Washington, D.C.

PANEL B

Panel of Educational Technology Manufacturers

Dr. Robert D. Gates
Director, Educational Operations
Philco-Ford Corporation
Fort Washington, Pennsylvania

Mr. William Greiner
Manager, State and Local Marketing
UNIVAC, Division of Sperry Rand Corporation
Washington, D.C.

Dr. Edward L. Katzenbach, Jr.
Vice President
Raytheon Company
Lexington, Massachusetts

Mr. Len Muller
Director, Instructional Systems Development
IBM Corporation
Armonk, New York

Mr. William Kilroy
RCA Instructional Systems
Radio Corporation of America
Palo Alto, California

PANEL C

Panel of Consultant Firms - ADP Training

Mr. Dave Allison
Brandon Applied Systems
30 E. 42nd Street
New York, New York

Mr. Frank Reilly
Booz, Allen & Hamilton
Management Consultants
Cafritz Building
1625 Eye Street, N.W.
Washington, D.C.

Mr. Dick Sprague
Touche, Ross & Bailey
60 East 42nd Street
New York, New York

Mr. Jack Veale
Technical Operations
1701 N. Kent
Washington, D.C.

PANEL D

Panel of Industrial Firms - ADP Executives

Mr. Lyle Brewer
Director, Systems
Eastman Kodak
Rochester, New York

Mr. Robert Parsons
Vice President, Systems
Eastern Airlines
Miami, Florida

Mr. H. J. McMains
Director, Analytical Support Center
American Telephone and Telegraph
150 Williams Street - Room 1116
New York, New York

SPECIAL SPEAKERS

Dr. Gabriel O'Fiesh
Director of the Center for Educational Technology
Catholic University
Washington, D.C.

TITLE: "Vital Concepts of PI and CAI for ADP Training"

Dr. Lawrence Stolurow
Director, Computer Center
Harvard University
Boston, Massachusetts

TITLE: "The Process of Machine-Learning and Employee Training"

Subject Matter Specialists

Dr. William Atchison
Director, Computer Sciences Center
University of Maryland
College Park, Maryland

Dr. Sylvia Charp
Director of Instructional Systems
Philadelphia City Schools
21st and Parkway Streets
Philadelphia, Pennsylvania 19103

Dr. Ralph Van Dusseldorp
Associate Superintendent
State Department of Public Instruction
University of Iowa
Iowa City, Iowa

Dr. Malcolm Gotterer
Professor of Business Administration
Pennsylvania State University
University Park, Pennsylvania

Dr. Herman Limberg
Director of Management Reporting
Office of Administration
Office of the Mayor
New York, New York

Mr. Fred Simmons
Director of Computer Technology
University of West Florida
Pensacola, Florida

Curriculum and Education Specialists

Dr. William Katzenmeyer
Department of Education
Duke University
Durham, North Carolina

Mr. Walter Corvine
Assistant Professor
Chicago State College
6800 South Stewart
Chicago, Illinois

Dr. David Shirley, Professor
College of Business and Public Administration
University of Arizona
Tucson, Arizona

PI and CAI Technical Specialists

Dr. Donald Hartford
Associate Director
Computing Center
Auburn University
Auburn, Alabama

Dr. Lawrence Stolurow
Director, Computer Center
Harvard University
Cambridge, Massachusetts

Federal Agency Participants

Mr. Park Anderson
Assistant Director
ADP Training Center
Civil Service Commission

Mr. Frederick Dyer
Office of Civil and Manpower Management
Navy Department

Mr. Howard Gammon
Assistant to Director
Center for Computer Science and Technology
National Bureau of Standards

Mr. Richard A. Gay
Chief, Systems Management Staff, Personnel
Public Health Service

Dr. Chester L. Guthrie
Deputy Assistant Archivist
for Records Management
National Archives and Record Service

Mr. Joseph Lowell
Director, ADP Training Center
Office of Career Development
Civil Service Commission

Dr. Richard Otte
Project Officer
Human Resource Branch
Division of Adult Vocational Research
U. S. Office of Education

Dr. Hugh Scott
Automation and Manpower Policy Officer
Civil Service Commission

Mr. William J. Shickler
Office of Manpower Policy
Evaluation and Research
U. S. Department of Labor

APPENDIX III.

ABSTRACT OF RESOURCE PAPERS DELIVERED AT CONFERENCE

COMPUTER ASSISTED INSTRUCTION

Abstract of a paper delivered by
Dr. Lawrence M. Stolurow of Harvard
University.

There is a real place for CAI in the spectrum of training problems with which we are faced. The problem is to see where it fits and how it can be put to use. It might be that we will try CAI and find that this is not the best way to go but this is not unique to CAI.

We should think of CAI as a dual purpose investment; one, to determine its limitations and capabilities, and secondly, to get mileage out of it in instructing students. In other words, it should not be investigated in a laboratory remote from the real situation. The ideal places for initial study are those existing systems (e.g., airline scheduling) capable of time sharing, multiple access, and teleprocessing.

CAI is not programmed instruction. The former is computerized, machine augmented instruction and is a very different concept than PI. Many people make the mistake of thinking they can dump existing PI onto a system but there is very little advantage from making such a simple transfer.

Our concept at Harvard is that CAI should provide a means of pretesting and developing instructional materials. It may turn out that the marketing or use of these materials may take a very different form. PI, of course, does not have this capability.

The basic concept in machine augmented instruction is that it is individualized -- that is its main purpose in terms of application. Moreover, a computer based system has two capabilities not present in other media; logic and memory which provides essentially a nervous system for whatever media you want to employ for instruction. This leads to the point that the two very basic conditions that you want to focus on in thinking of machine augmented instruction are first that its multi-media -- and it also has a multi-mode capability.

To demonstrate what is meant by multi-media, we can look at the following slides. These consoles are primitive and indicate the limited nature of those which are available. Much more human engineering needs to be done before we have a learning environment. Existing consoles are adaptations of input/output equipment designed for other purposes.

(The speaker narrated the following slides and commented on each):

Slide No. 1 - The console is a small CRT and keyboard with an IBM 360/50 as central processor, used at the University of California to teach mathematics. The instruction burden is primarily carried on by the teacher but individualization comes in by allowing the student to see a display of his own concepts. For example, in teaching a mathematical function, the student can enter the variations in the parameter and see what the function looks like.

Slide No. 2 - A system individually designed for CAI but concerned primarily with display rather than response. Left hand display is a rear view projection of a 35 MM film, and at the right is a fixed message display for messages repeatedly used. The film display is a step toward the kind of learning environment which is needed because it gives you cheap storage.

Slide No. 3 - An IBM 1050 typewriter, capable of operation in teleprocessing mode. To the left is an additional RPQ. The top segment is a screen for a random access slide projector in synchrony with text display. This is essentially an AV console.

Slide No. 4 - A Philco-Ford, a standard TV tube modified for CRT display which permits showing of tapes, TV displays or hook up to live broadcasting. Also adapted is a keyboard and light pen response. The light pen capability adds quite a bit but it also adds to the cost due to the coding, programming, and delay in materials preparation.

Slide No. 5 - The console for the IBM 1500 system. It contains the keyboard, the CRT, an image projector, audio, the light pen, and a microphone for recording vocal responses.

All of the foregoing are a pass at the problem rather than solving it. None have any real human engineering behind them and this remains one of the sore spots in the whole input/output problem for CAI or machine augmented instruction. However, the main point was to show that CAI is multi-media. If this multi-media integration capability can be put together in an appropriate educational package, then we are moving ahead in terms of our training requirements.

The second major point to make about CAI or machine augmented instruction is that it is multi-mode. The first mode is the problem-solving mode.

> "By problem solving, I am saying that we are dealing with a situation in which the capabilities of the computer as a calculating system are being employed with each individual sitting at a console putting in his data, defining his processing program and getting the system to perform what it has been designed to perform, namely calculation. BASIC is a language which is being used on the GE systems. It's readily learned by students. It's simple enough to take care of most of their physics, math, chemistry problems, statistics, etc. Essentially the console is being used as an elaborate desk calculator. The faculty or staff in an educational institution needs to know very little more about computers, languages, about time-sharing, etc., than they now know. You don't have to build up your instructional staff. You simply let your students learn a language and the staff can assign the usual problems and maybe more of them because the students now have a capability of handling more and getting more problems solved."

> "Drill and practice is another mode. In this mode the instructional staff has to make decisions about what kind of drills and what kind of practice the students are going to need in support of the instructional effort. And then they have to work with some computer types to generate these materials or write themselves, in which case there is greater instructor involvement, teacher involvement, or author involvement in the process. The student on the other hand obviously responds in natural

language to natural language displays and so he needs to learn very little in order to use such a system. The main advantages are that the student can be given specific and tailored practice to his particular needs. Once these needs are determined by some other means the system can support the skill development."

"The third mode is one which is called inquiry mode which is your information-retrieval mode of the application of the system which has different system requirements. You need algorithims; you need some kind of analysis of your data base; you have to set up your files; you have to maintain files. An example would be the application at SDC where they took the Golden Book Encyclopedia, loaded the information in it on the system and then set up research algorithims. One can ask why it rains and what ever the Golden Book said in answer to that question will be displayed on a console to the student."

"The fourth mode is the tutorial mode. In the tutorial mode we are taking the application of machine augmented instruction, where the responsibility for an instructional program has been assumed by somebody who is called an author or educational programmer, where he is responsible for taking individuals from some point of minimum level of confidence and moving them to some set of objectives in terms of improved confidence. The logic for doing this -- the way in which one formulates what are known as teaching strategies -- is one of the problems. Another problem is the allocation of materials to media -- decisions have to be made about this, as well as the strategies."

"The fifth mode is probably the one that is the most primitive but potentially the most important mode to us, particularly at this stage of the game. This is what is called the author mode, where we want to develop the capability of the system to generate instructional material -- to actually produce instructional materials from general specifications. The question is what kind of modules, what kind of algorithims do we need in order to combine these modules to provide texts that would support a particular instructional objective and generate it so that it doesn't have to be prepared beforehand and then loaded on the system, but rather the modules could be loaded and economy achieved in this way.

Specific examples of what we have done so far in this mode are to generate syllogisms in the support of a logic course where we would not have to write every syllogism in advance, in fact, not know what syllogism the student is going to get. All we know is that at this point in time, he is to get a syllogism of a certain type in either abstract or concrete form. So if it's abstract he gets it in a's and b's or all x's, y's and so on. If it's concrete, he will get a verbal description instead."

The approach to tutorial instruction is in two phases, the pretutorial and the tutorial.

The pretutorial phase (shown in Figure 11) must be able to receive the inputs of student characteristics and specific behavioral objectives of instruction so that a teaching program can be selected.

"The three alternative search strategies are indicated, the most interesting one of which is at the bottom. The top one is where you come up with more than one possible program for the individual and have to use economic criteria for reducing it to one. The middle is where you get one program. The bottom is where you come up with none but you have a training requirement or a quota and you have to make some changes. One specifies that the change in the entry level is one possibility -- if it's a statistics course, you might find that he is deficient in his "algebra and therefore you give him an algebra refresher before you allow him to take the statistics course. That's indicated by the top flow through the diagram. You might accept a greater risk and accept individuals with lower entry levels who have a higher aptitude in the particular relevant area and increase your risk, but also increase your take in terms of potentially trained people. The other is to change the set of topics that you're going to require, the time allotment, or the final performance level. One can make any one of these changes or a combination of them and set them up in a priority schedule, and the system would automatically be able to process individual students when they come for instruction and take care of them so that you would meet your quotas. Now that's the pretutorial phase. A capability for doing these things needs to be in a total system."

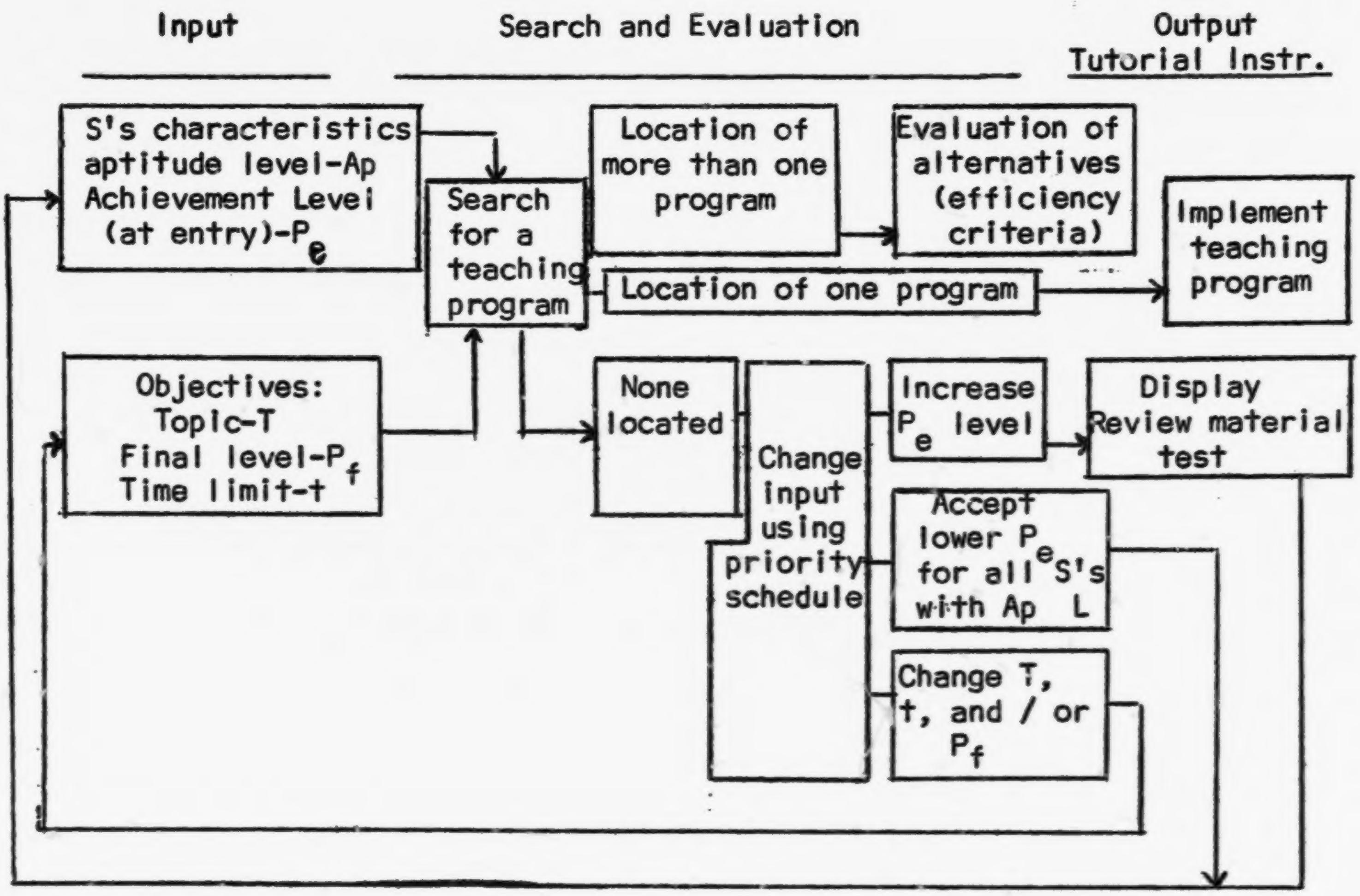
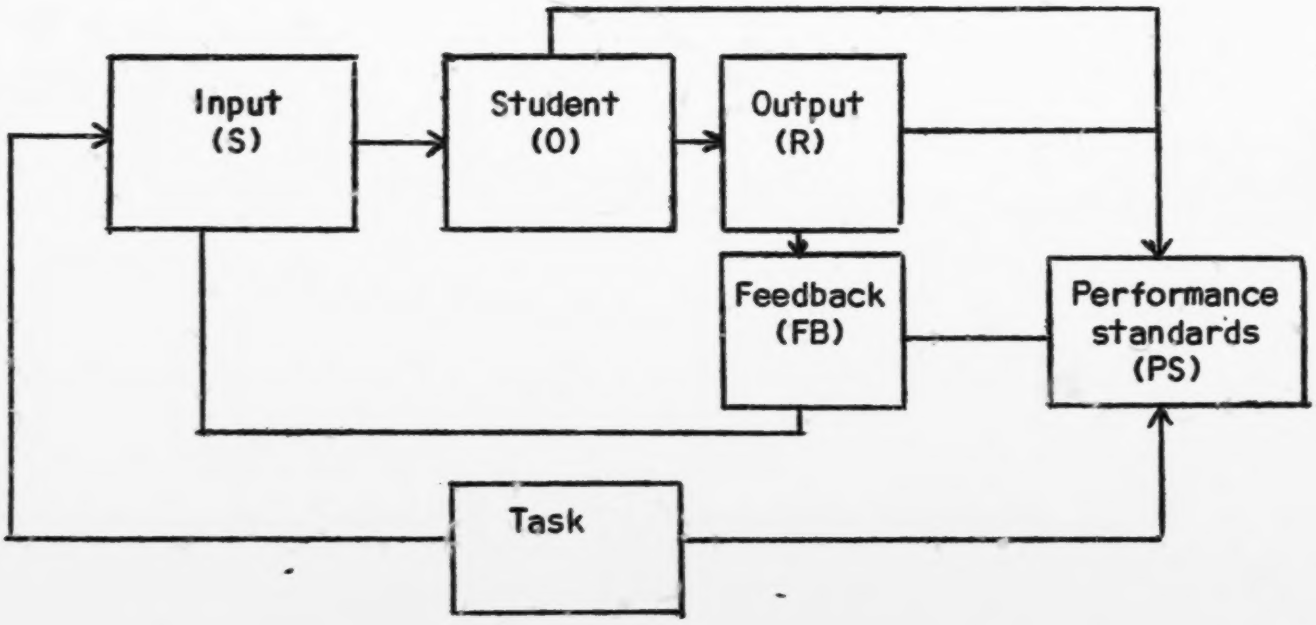

Input
Search and Evaluation
Output
Tutorial Instr.
S's characteristics
aptitude level-Ap
Achievement Level
(at entry)-Pe
Search
for a
teaching
program
Location of
more than one
program
Evaluation of
alternatives
(efficiency
criteria)
Implement
teaching
program
Location of one program
Objectives:
Topic-T
Final level-Pf
Time limit-t
None
located
Change
input
using
priority
schedule
Increase
Pe level
Display
Review material
test
Accept
lower Pe
for all S's
with Ap L
Change T,
t, and / or
Pf

Figure 1. The pretutorial decision process



The Tutorial instructional system
Figure 2.

Figure 2.

Tutorial Process. Figure 2, concerns the basic elements and relationships in the tutorial process. Feedback includes the idea of reinforcement and, therefore, is an explicit recognition of the need to make selected events contingent upon response. Feedback is recognized as a stimulus event that follows response, as distinguished from the cue and eliciting stimulus functions. Feedback is a more descriptive term since school situations involve both informational contingencies and reinforcement contingencies.

The performance standard (Figue 2) is a critical function in the making of decisions in experimental studies of learning. Teaching can no longer allow performance standards to go unnoticed as a critical part of the definition of the learning task; their function needs to be made explicit.

Performance standards are the various principles used to generate the criteria employed in making decisions about the correctness of each response. Standards vary with school grade and often with a student's ability. Teachers impose different standards upon different students in a class and in this way define different tasks for these students.

Performance standards used by the teacher at an early period can be taught to students at later periods. This makes performance standards a part of the material covered in a course and thus available to the students who can later use them to evaluate their own performance. The student who is taught rules of grammar, for example, can apply these to his own writing. Once he does this, he becomes his own teacher by supplying himself with knowledge of results and, if he verbalizes the rule when he corrects his own work, even with information feedback. This links the rule to the cues of the material and establishes an even more effective association for later use.

"PROGRAMMED INSTRUCTION"

Abstract of a paper presented by
Dr. Gabriel O'Fiesh, Director of
Center for Educational Technology
Catholic University, Washington, D. C.

"I am very gratified to tell you that I received a letter several days ago containing a document signed by the Commander of the Air Training Command, the largest training establishment in our nation, saying that the concept of program instruction has proved itself so effective in the research and development staffs it will be applied across the board to all the air training programs."

"The basic problem we must address ourselves to in the new field of science of education is -- how do we use the psychology we are talking about to train the technologists? We must concentrate our limited resources on developing them to turn out the massive amounts of materials in our society which are designed to produce systems which will be adopted to the accelerating requirements of our needs. Education faces a crisis. The sheer force of the mushrooming population makes our traditional educational system inadequate. ...The measures which we have been forced to take to meet today's needs will be totally inadequate tomorrow."

"The rapid accumulation of information in almost every discipline and endeavor has forced a few of us in the field of education to search for new methods of acquiring, assembling, analyzing, and disseminating the almost overwhelming new knowledge of our age. The development of techniques and devices such as educational television, teaching machines, audiovisual communication, and above all the programmed instruction process itself has been hailed as revolutionary and capable of solving problems associated with the knowledge explosion."

"These devices and aids are considered by some of us not to be revolutionary in themselves but only to the needs of education. It is great for correcting our teacher shortages, illiteracy, etc. It provides us with a means of revising education. It provides us with a means of increasing the effectiveness of our curriculum. It helps us in the field of learning theory, in the process by which human beings learn. It is becoming apparent to us that the development of packaged learning systems - the same assembly line process that Bessemer brought to steel and Ford brought to the automobile - unless we allow this to take place, it is doubtful we will be able to solve the rapidly accelerated problems of our society."

Increasing technological change, exploding world population, accelerating dropout rates, the need for commencing better education earlier in life -- these are illustrationsof these problems.

> "An educated citizenry is one of the most effective tools we have for economic and political growth and development.
>
> . . . .
>
> Statesmen, economists, and many other groups of national and international leadership are recognizing that the only thing more expensive than education is the lack of it.
>
> . . . .
>
> These problems cannot be reliably solved as long as current educational conditions exist; they are not going to be reliably solved as long as we invest in the same kind of economic solution. And in a society that puts moremmoney into the programming of our major TV networks in one week than we do in all educational TV in one year!"
>
> "In order to break this frustrating circle, we need a new, vigorous approach.
>
> . . . .
>
> We need something to overcome the traditional constraints of making the best instruction possible available to every individual al -- including the teachers. Through the process of programmed instruction and computer-assisted institutional facilities, this possibility can become a reality...."
>
> "Through programmed instruction, the best tutorial methods can be packaged and mass-produced for students. Through packaged tutorial learning systems the few master teachers and their skills and the teachers of teachers we have in our society can be relieved of the many dull routine aspects of the didactic process and devote their creative energies to those precious interpersonal moments between student and teacher and between teacher and student-teacher."
>
> "I dropped into one of our western cities not long ago and saw the most amazing machine I ever saw in my life -- 25 knobs on it. This was a coffee vending -- not education vending. It had a knob for sugar and no cream, cream and no sugar, heavy sugar and cream, light sugar and light cream, etc. Yet students all go in the classrooms and get the same black coffee curriculums. We can't seem to assemble the same resources so all of our people can have continuous education."
>
> "The education profession must retool immediately to cope effectively with the everchanging educational needs of our people. Innovation is needed in the retooling process and conventional pedagogy is of little--if any--value in training teachers to teach as they were taught -- not in the manner in which they learn."

"I would like for you to think of a school which would operate continuously whenever there are students and where teachers are not needed. There would be no faculty in the usual sense. The learning systems that the student would use would be based on the process of programmed instruction. The purpose of programmed learning systems would be to fill a void where there is a serious lack of both skilled teaching manpower and effective teaching tools for carrying out the needed educational and training programs. Skill and knowledge requirements in our society are of such magnitude and unique nature that no conventional remedies such as increasing the number of specialists personnel and material resources or building more school rooms and training facilities can satisfy our needs in the required time."

"What is needed is an inexpensive group of learning systems to meet this need directly. What is needed is the engineering development of these packaged courses of instruction which will minimize the need for competent master teachers and classroom facilities -- significant in those circumstances where competent teachers and adequate facilities are not available. The programmed instruction process is basic to this packaged education."

"Through programmed instruction we can simulate (or package) the tutorial approach. We can lead the student one optimal step at a time along the learning path. To one student, it is a small step; to another student, it is a large step. We can get the student to respond so that his response always carries him a little closer to the ultimately desired learning."

"In 1964, Wilbur Schraum, in his review of research in programmed instruction, stated unequivocally that five years of intensive research demonstrated that students do learn from programmed instruction. Programmed instruction, like no other approach to the teaching that we have had, is dropping essentially "what is dysfunctional" from learning experience and developing what is truly functional."

"This is not to say that programmed instruction will provide all the answers, nor is it to say that it is in and of itself the learning technology that our society needs. It does mean, however, that its adherents have concerned themselves with testing the experiences which they hypothesize will lead to successful learning.

. . . .

"Through programmed instruction we are starting to think about applying engineering to solving educational and training problems, not to mechanize education, but rather to develop learning technology to the point where we can shoot with a bullet instead of a shotgun."... Within ADP there is a tremendous need for training. The expansion of the industry itself has necessitated the training of thousands of programmers and operators. We are training these people, for the most part, using conventional means. Some companies have programmed texts to teach the fundamentals of programming and instruction sets for particular machines. The effort to use the ADP system itself to train the people is minimal."

"Programmers have time while awaiting debug runs. Operators have long relatively idle periods while long jobs are being run. The potential now exists through time share, teleprocessing, and multiprocessing to use the machine for both production and instruction."

. . . .

"The big mistake that is being made is simply mechanizing the classroom approach. Some think you merely mechanize the textbook. CAI is much more than this. It is the application of the programmed learning approach. We need to know specifically what the person needs to learn -- not just "to learn how to program the XYZ 246." What does a programmer need to know if he is going to be a successful XYZ 246 programmer? How can we know when he has achieved these objectives? What is the best strategy for presenting the material to give optimum reinforcement and retention? The technician in the ADP feels he can write the course without going through all this "Mickey Mouse." However, the student learns in spite of, not because of the teaching. It takes time and money to do the job right, but management feels they can shortcut the process. Thus, they spend time and money to do the job wrong."

. . . .

"We not only need educators, we need a new breed we might call "the educational systems engineer." We need to experiment and extrapolate from our experiments with very little guidance from the laboratory of the educational psychologist and learning theorist. We need to bridge the gap between basic research and technology. We need to study and understand more fully than we presently do the impact of the stimulus-configurations (message design) which we impose upon students and identify those which actually produce changes in behavior."

. . . .

"Once we do isolate a process or method and say, "Yes, this particular set of stimuli presented in this format, under these specific conditions to these particular individuals, will reliably produce these specific changes in their behavior," the second question we must raise (and now we get to the hardware) is, "How do I instrument it? How do I replicate it? How can I engineer the mass production of the packaged process?"

. . . .

"The problem is equally of education in learning design, as well as the hardware that we are talking about."

APPENDIX IV

Selected Organizations Involved in Educational Technology

THE ADMINISTRATIVE MANAGEMENT SOCIETY
Willow Grove, Pennsylvania 19090

AMERICAN MANAGEMENT ASSOCIATION, INCORPORATED
135 West 50 Street
New York, New York 10020

AMERICAN TELEPHONE AND TELEGRAPH COMPANY
195 Broadway
New York, New York 10007

THE AMERICAN UNIVERSITY
Center for Technology and Administration
Downtown Campus
2000 G Street, N.W.
Washington, D.C. 20016

ANALYTICAL ASSOCIATES, INCORPORATED
420 Lexington Avenue
New York, New York 10017

APPLIED DATA RESEARCH, INCORPORATED
Route 206 Center
Princeton, New Jersey 08540

ARKAY INTERNATIONAL DIVISION
Comspace Corporation
2372 Linden Boulevard
Brooklyn, New York 10108

THE ASSOCIATION FOR BANK AUDIT, CONTROL, AND OPERATION
205 West Touhy Avenue
P.O. Box 500
Park Ridge, Illinois

ASSOCIATION FOR COMPUTING MACHINERY
211 East 43 Street
New York, New York 10017

ASSOCIATION FOR EDUCATIONAL DATA SYSTEMS
1201 16 Street, N.W.
Washington, D.C.

AUTOMATION INSTITUTE OF AMERICA
Subsidiary of C-E-I-R., Inc.
760 Market Street
San Francisco, California 94102

AUTOMATION SCIENCES, INCORPORATED
275 Madison Avenue
New York, New York 10016

AUTOMATION TRAINING CENTER
Box 3085
Papago Station
Scottsdale, Arizona 85257

BONNER & MOORE ASSOCIATES, INCORPORATED
500 Jefferson Building
Houston, Texas 77002

BRANDON APPLIED SYSTEMS, INCORPORATED
30 First 42 Street
New York, New York 10017

C-E-I-R, INCORPORATED
Institute for Advanced Technology
5275 River Road
Washington, D.C. 20016

COMPUTER COMMAND AND CONTROL COMPANY
Suite 1315
1750 Pennsylvania Avenue, N.W.
Washington, D.C. 20006

UNIVERSITY OF CALIFORNIA EXTENSION
Los Angeles
California 90024

CENTER FOR PROGRAMMED LEARNING FOR BUSINESS
Bureau of Industrial Relations, Graduate School of Business Administration
The University of Michigan
340 South State Street
Ann Arbor, Michigan 48104

COLUMBIA UNIVERSITY
Executive Programs, Graduate School of Business
Uris Hall
New York, New York 10027

COMPUTER RESEARCH INSTITUTE
9506 Magnolia Avenue
Riverside, California 92503

COMPUTER USAGE EDUCATION, INCORPORATED
Subsidiary of Computer Usage Company
51 Madison Avenue
New York, New York 10010

COMRESS, INCORPORATED
2120 Bladensburg Road, N.E.
Washington, D.C. 20018

CONTROL DATA INSTITUTE
Division of Control Data Corporation
3255 Hennepin Avenue
Minneapolis, Minnesota 55408

DATA PROCESSING MANAGEMENT ASSOCIATION
International Administrative Headquarters
505 Busse Highway
Park Ridge, Illinois 60068

DETROIT RESEARCH INSTITUTE
12 East Hancock
Detroit, Michigan 48201

DIGITRONICS CORPORATION
Albertson
New York

DOCUMENTATION, INCORPORATED
4833 Rugby Avenue
Bethesda, Maryland 20014

ELECTRONIC COMPUTER PROGRAMMING INSTITUTE
Empire State Building
New York, New York 10001

EMORY UNIVERSITY
School of Business Administration
Atlanta, Georgia

ENTELEK, INCORPORATED
Newburyport
Massachusetts 01950

FLORIDA ATLANTIC UNIVERSITY
College of Business and Public Administration
Boca Raton, Florida 33432

FRIDEN, INCORPORATED
Subsidiary of the Singer Company
2350 Washington Avenue
San Leandro, California 94577

GENERAL DYNAMICS
One Rockefeller Plaza
New York, New York

GEORGIA INSTITUTE OF TECHNOLOGY
Rich Computer Center
School of Information and Science
Atlanta, Georgia

INDUSTRIAL MANAGEMENT CENTER
370 Concord Road
Weston, Massachusetts 02193

INDUSTRIAL MANAGEMENT SOCIETY
330 South Wells Street
Chicago, Illinois 60606

INFORMATICS, INCORPORATED
5430 Van Nuys Boulevard
Sherman Oaks, California 91401

THE INSTITUTE FOR MANAGEMENT AND COMPUTER EDUCATION, INC.
135 West 50 Street
New York, New York 10020

INTERNATIONAL ACADEMY DIVISION
LSI Service Corporation
Washington, D.C.

INTERNATIONAL ACCOUNTANTS SOCIETY, INCORPORATED
209 West Jackson Boulevard
Chicago, Illinois 60606

INTERNATIONAL BUSINESS MACHINES
Education Department
Poughkeepsie, New York

INTERNATIONAL CORRESPONDENCE SCHOOLS
Scranton
Pennsylvania 18515

LEARNING FOUNDATION INSTITUTE
Executive Division
505 Fifth Avenue
New York, New York 10017

LING-TEMCO-VOUGHT INCORPORATED
Arlington
Texas

MANAGEMENT DEVELOPMENT INSTITUTE
130 West Lancaster Avenue
Wayne, Pennsylvania 19087

MANAGEMENT [redacted]INING INSTITUTE
A Division of the Diebold Group, Inc.
430 Park Avenue
New York, New York 10022

UNIVERSITY OF MICHIGAN
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